From our friends up North

FAST-SETTING CONCRETE

or

4 x 4 CONCRETE !

CONCRETE PAVEMENT CONFERENCE

SAN DIEGO, CALIFORNIA

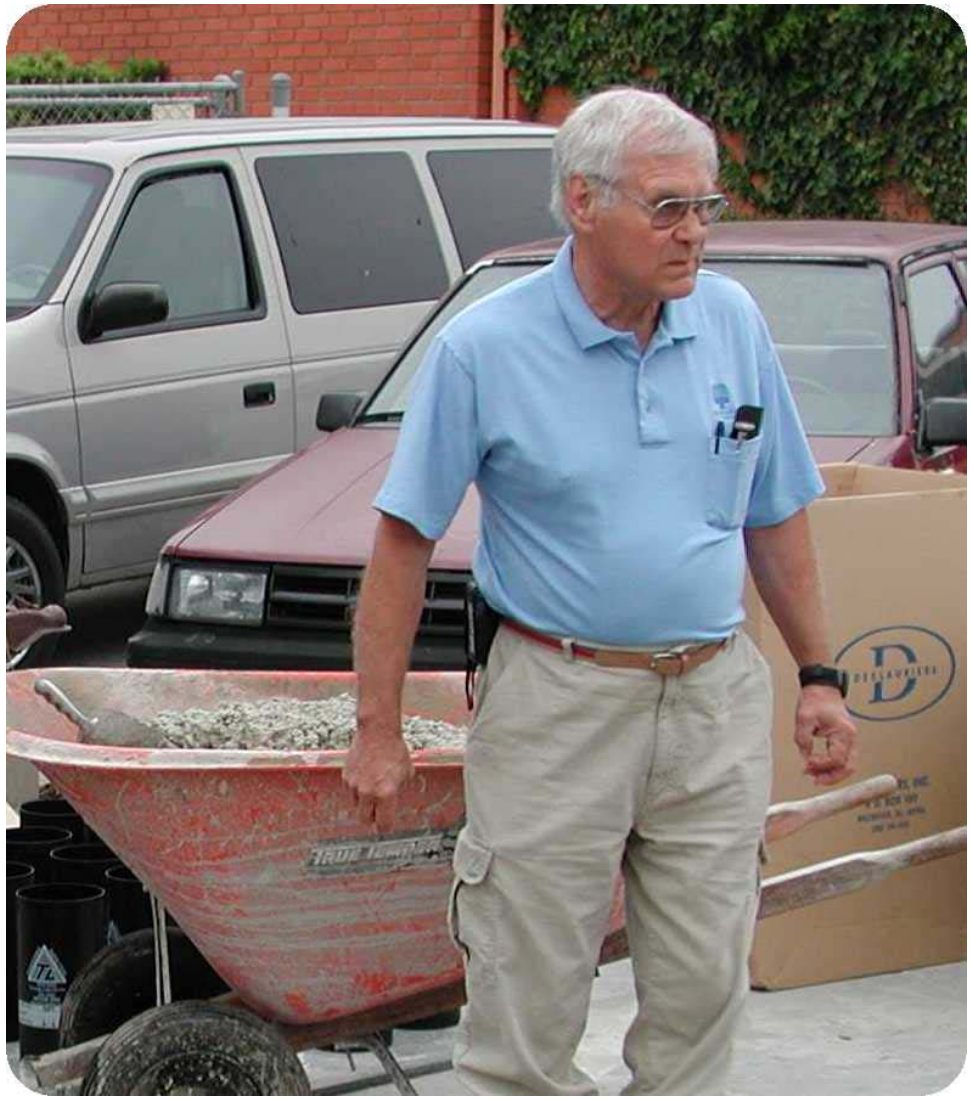
DECEMBER 4-5, 2001

JIM ANDERSON

MANAGER ENGINEERING SERVICES

I would rather be in the field.

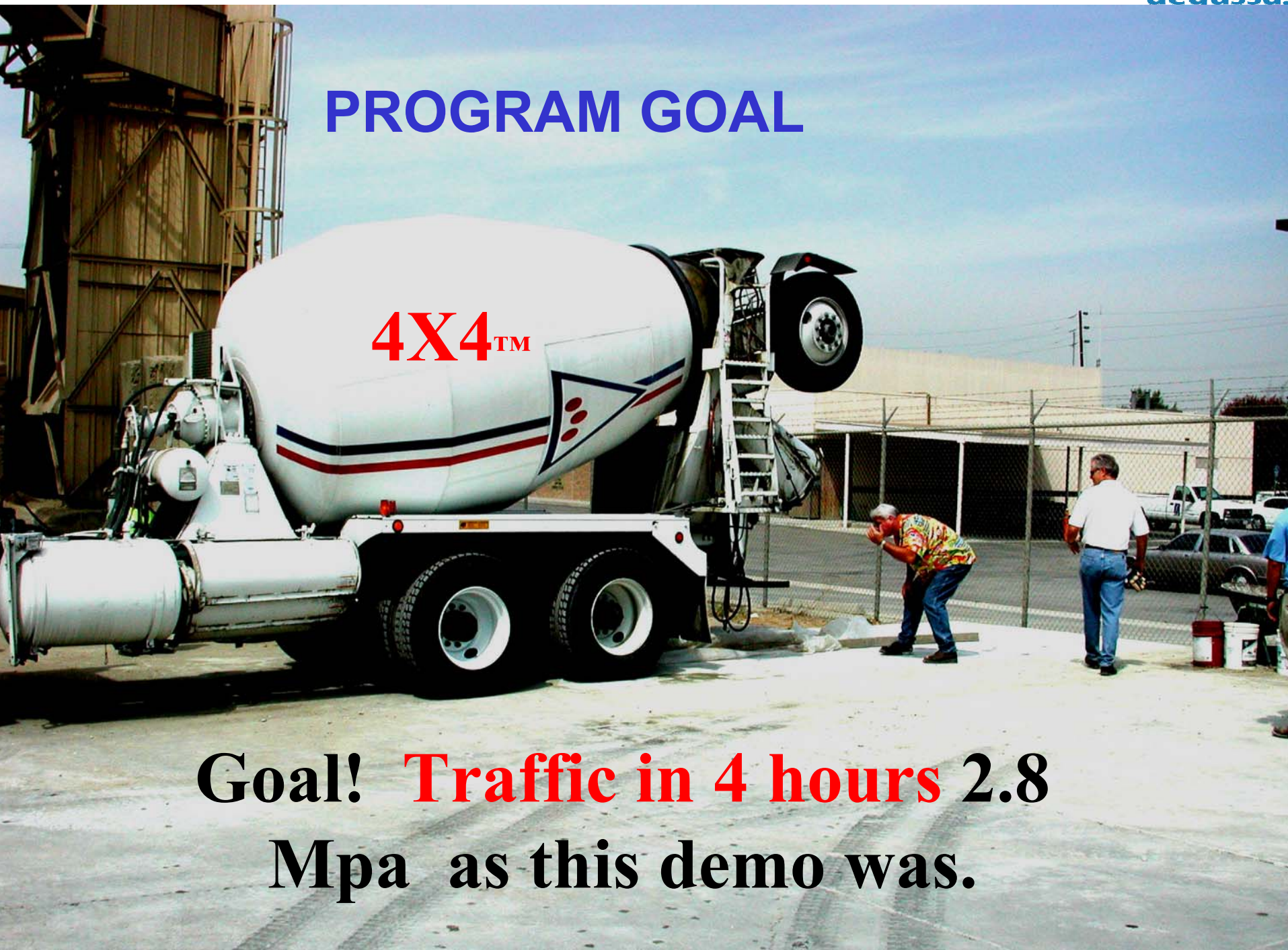
I am not as mean as I look, I just get into it.



IF WE ALWAYS DO WHAT WE ALWAYS DID

WE WILL ALWAYS GET WHAT WE ALWAYS GOT!

Time to think differently!


PROGRAM GOAL
4X4™
Goal! Traffic in 4 hours 2.8
Mpa as this demo was.

VOLUME NEEDED TO RUN COMPLETE TRIALS

NOT FROM 3 CU.FT.

BAG CHARGING OF R/M TRUCK

4 X 4 REQUIRED SOME NEW THINKING

- LAB SIZED BATCH LIMITATIONS
- MASS EFFECT IMPORTANT
- NUMBER OF BEAMS
- CYLINDERS DESIRED

HISTORY

REPLACE CONCRETE WITH OTHER MATERIALS like AC.

WAIT FOR DAYS OR WEEKS FOR STRENGTH AS MANY OTHER STATES

- CALTRANS CAN'T WAIT
- 2.8 Mpa 400 Psi IN HOURS NEEDED

Master Builders Partners
Made 4 X 4 possible

- Caltrans Translab
- National Concrete
- A&A / Associated
- Teichert Ready Mix
- Other Concrete producers
- Chumo Construction

National Concrete

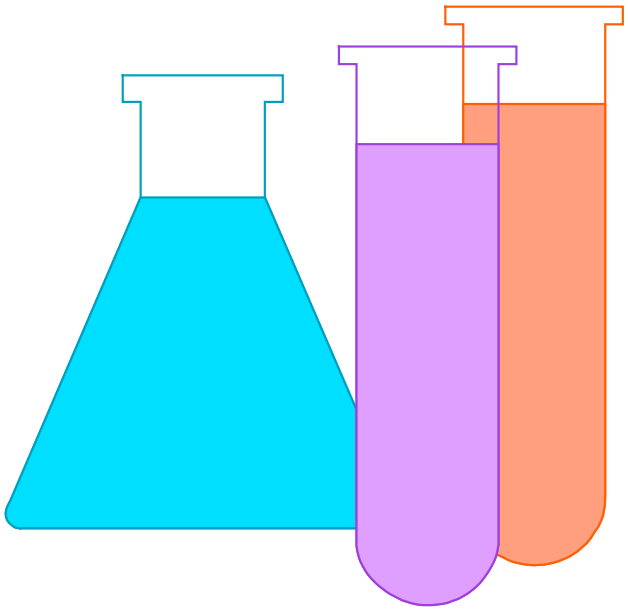
4 X 4 CONCRETE DEVELOPMENT

- **CALTRANS TRANSLAB**
  - 2.8 Mpa GOAL ELUSSIVE
- **FIELD LAB TRIALS**
  - EVALUATED MANY
    - CEMENTS
    - ADMIXTURES
    - AGGREGATES
- **MASTER BUILDERS LABORTORY TRIALS**
  - GUIDED SELECTION BY NUMEROUS PROCEDURES
- **FIELD TRUCK LOAD TRIALS**
  - ESTABULISHED
    - MIX
    - PROCEDURES

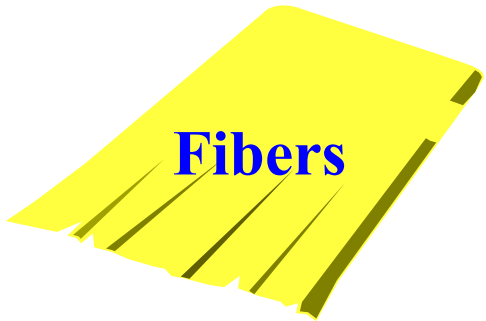
BREAKTHROUGH

- **HIGH PERFORMANCE CEMENTS**
  - NOT ALL CEMENTS ARE CREATED EQUAL
  - NEED TO BE RESPONSIVE TO ADMIXTURES
- **GLENIUM HIGH RANGE WATER REDUCERS**
  - DRAMATIC WATER REDUCTION WHILE NORMAL SETTING
- **NON-CHLORIDE ACCELERATORS**
  - COMPATIBLE WITH OTHER ADMIXTURES
  - USED AT DOSAGES HIGHER THAN NORMAL
- **HYDRATION CONTROLLING RETARDER**
  - SUPPENDS HYDRATION AS NEEDED
  - PROVIDES WORKING TIME / POT LIFE

Producing
High-Performance Concrete

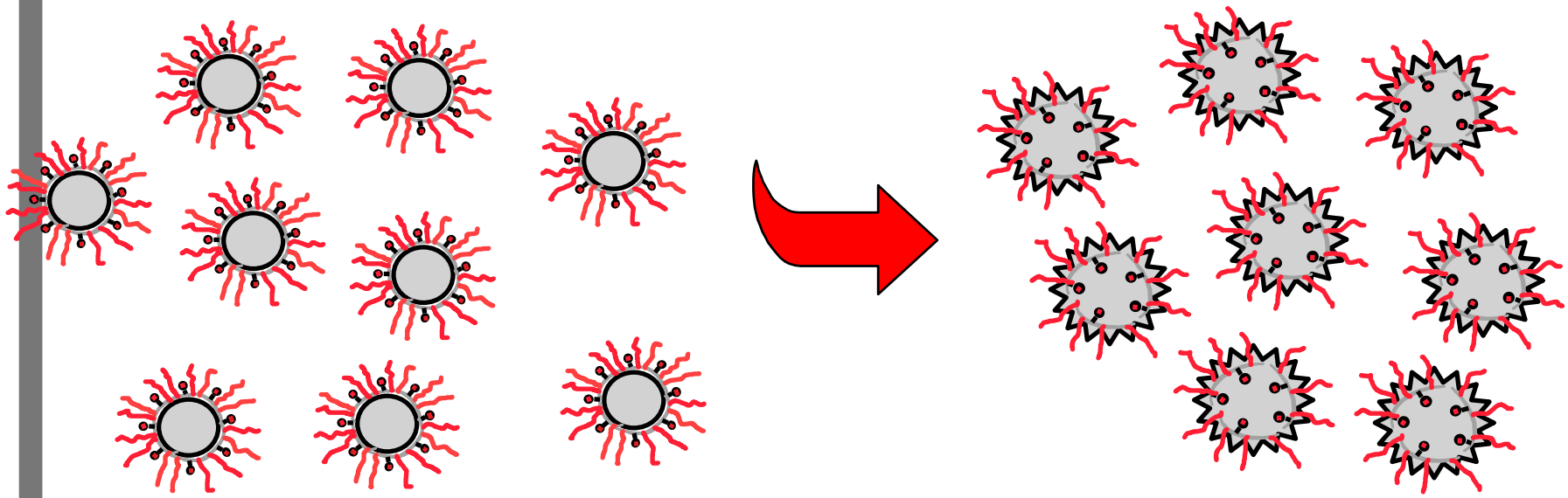


Specialty Chemical Admixtures



Mineral Admixtures

Mechanism of Action for GLENIUM™ Technology



Improved dispersion stability =
Better workability retention

Control Hydration - How?

DELVO

Figure 1

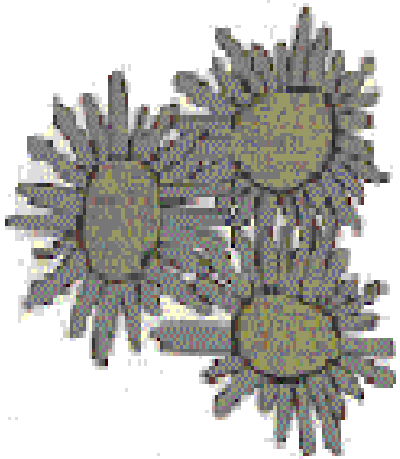


Figure 2

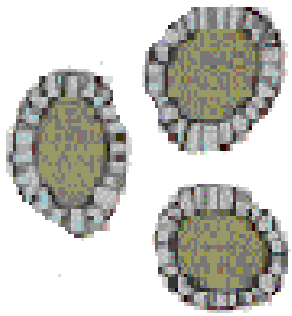


Figure 3

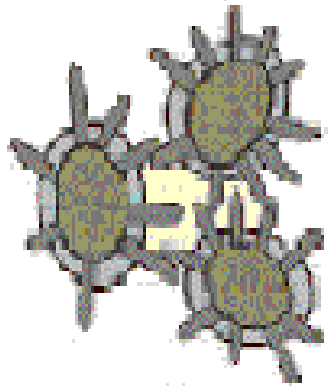
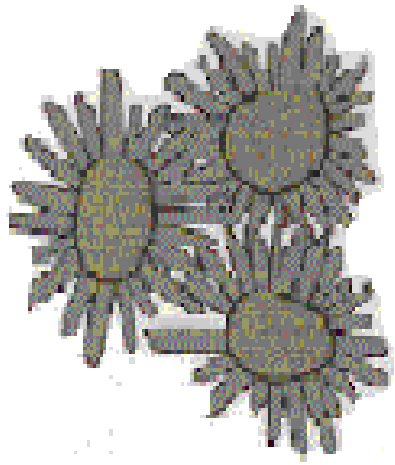


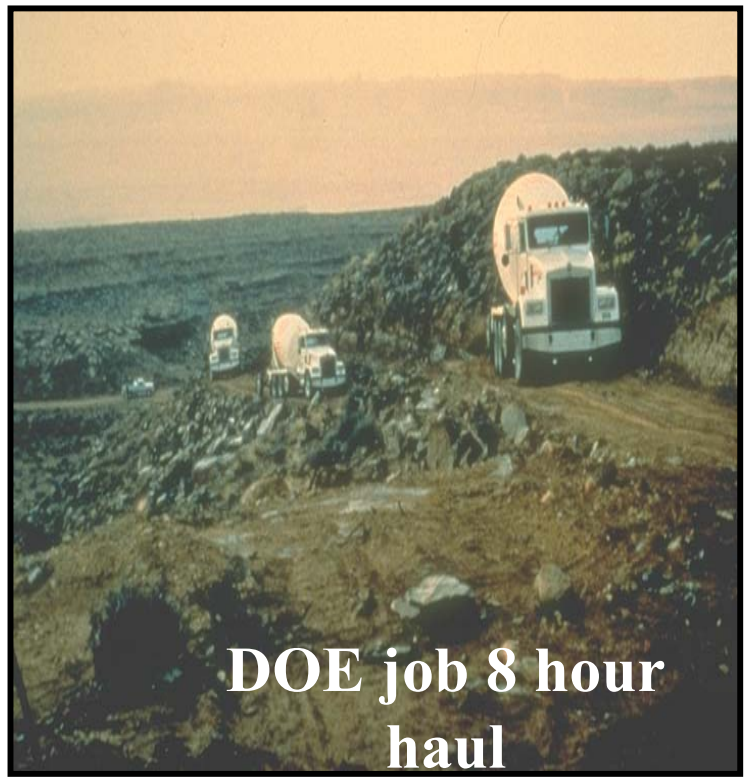
Figure 4



Benefits of Stabilization with Delvo (hydration controlling retarder)

- Controls hydration / working time.
- Extends the service area of ready-mixed plants.
- Reduces or eliminates premature setting.

- Capable of controlling set for hours to days in conventional concrete.



Checking load before accelerator

Accelerator added at job when concrete is needed!

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Tests & Methods Used
many continue

- **Plastic properties**
  - slump / flow / penetration
  - temperature of slab as placed & during first day / as tested
  - unit weight, set time, workability, finishability
- **Hardened properties**
  - strength flexural & compressive 4-6 hours after placement &
    - ages to 28 days
- **Long term tests**
  - durability, rapid chloride permeability,
  - volume change / shrinkage

TEMPERATURE AN INDICATOR

TYPICAL TEMP GAIN IN SLAB

FIELD RANGE TO DATE 75-145 F

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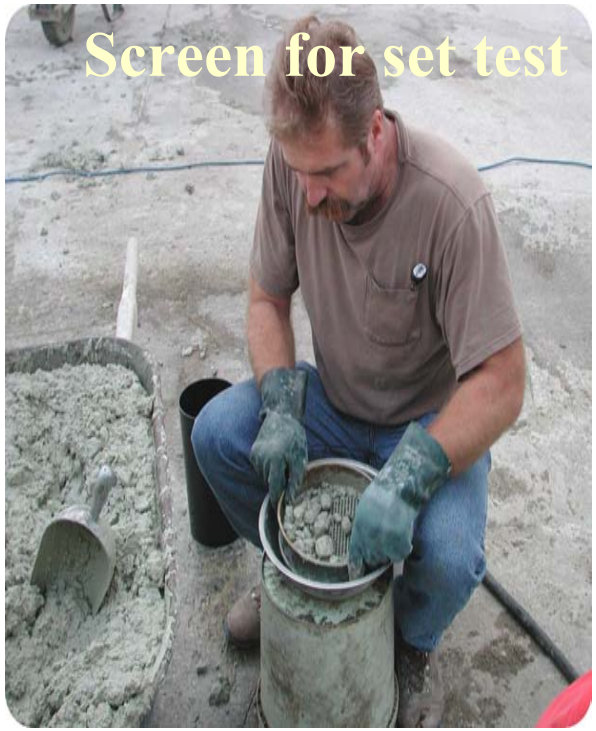
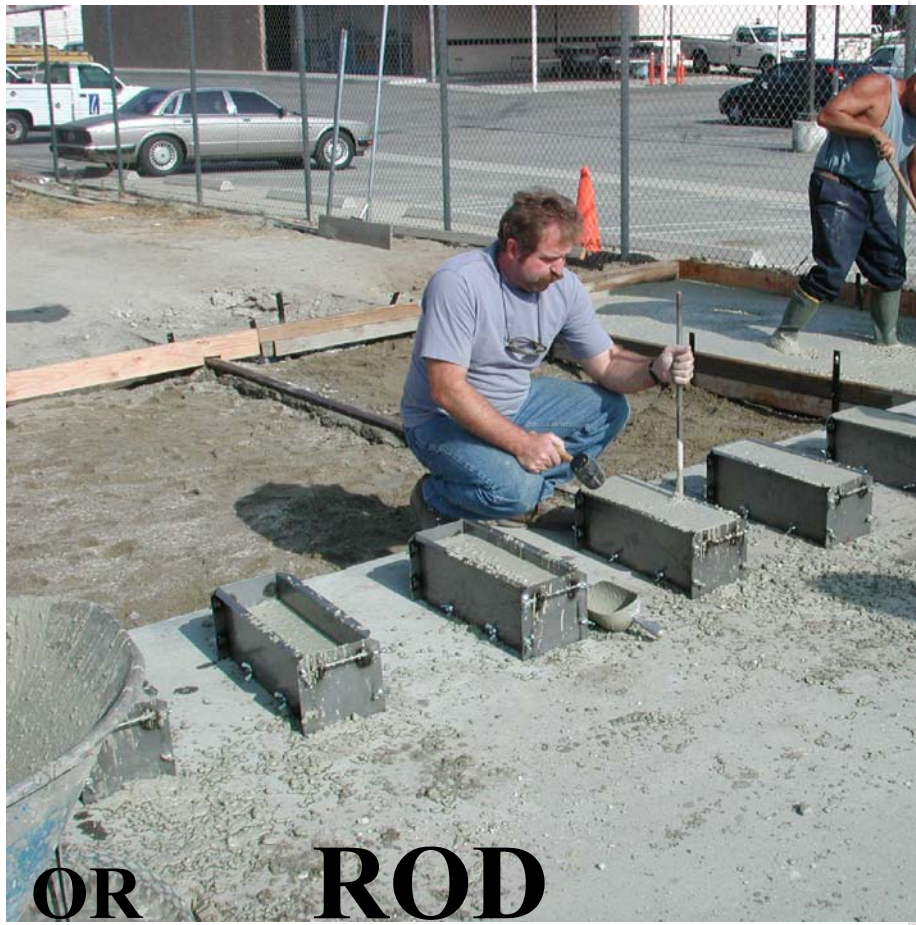
SET TIME TEST



At National Concrete

Slump / Penetration

CASTING BEAMS

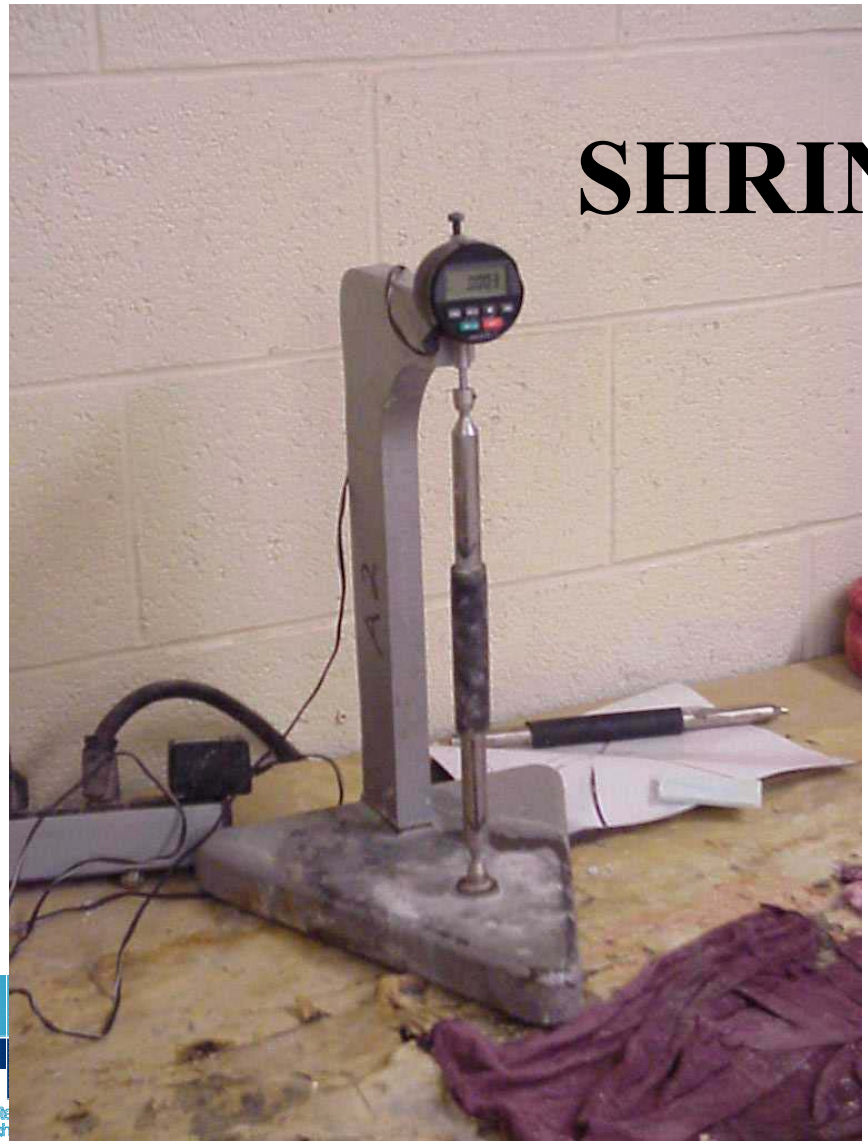


VIBRATE

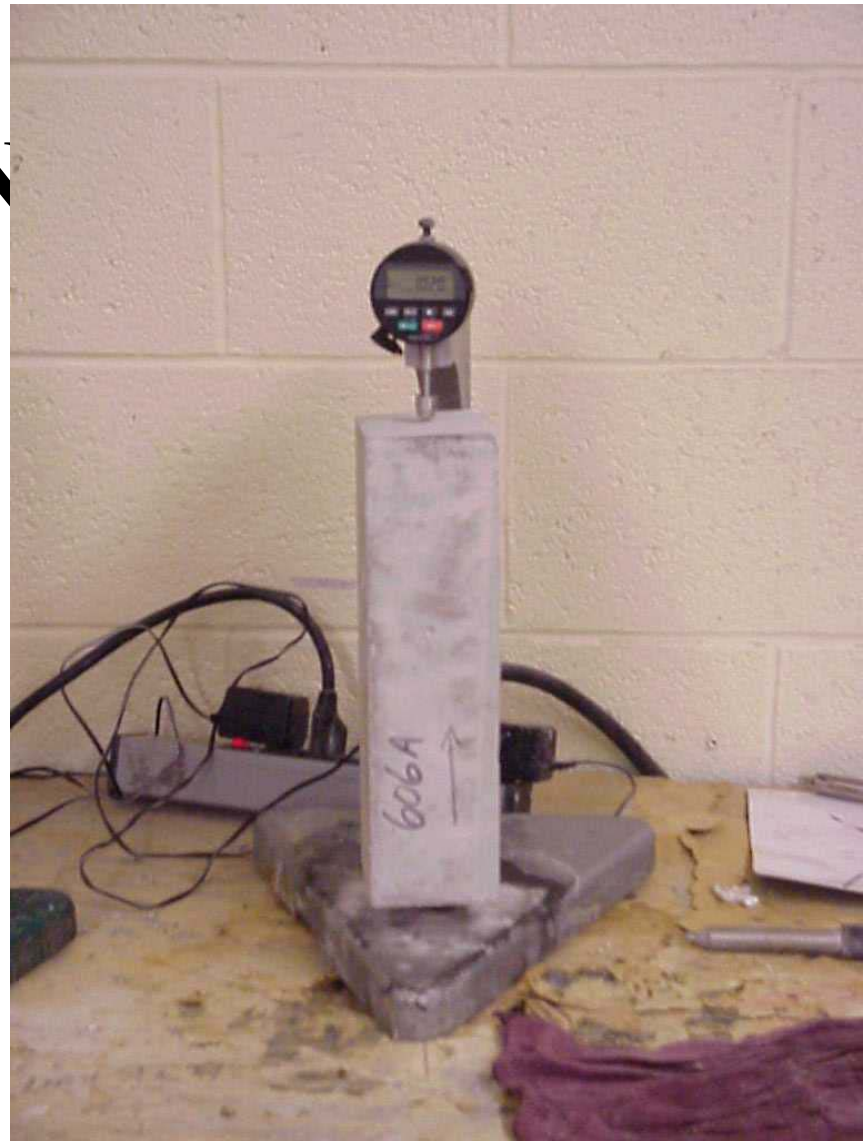
OR ROD


Qualified Testers? ? ?
me
John
<Dan
Mac
Dr. J
Tom

ASTM C157



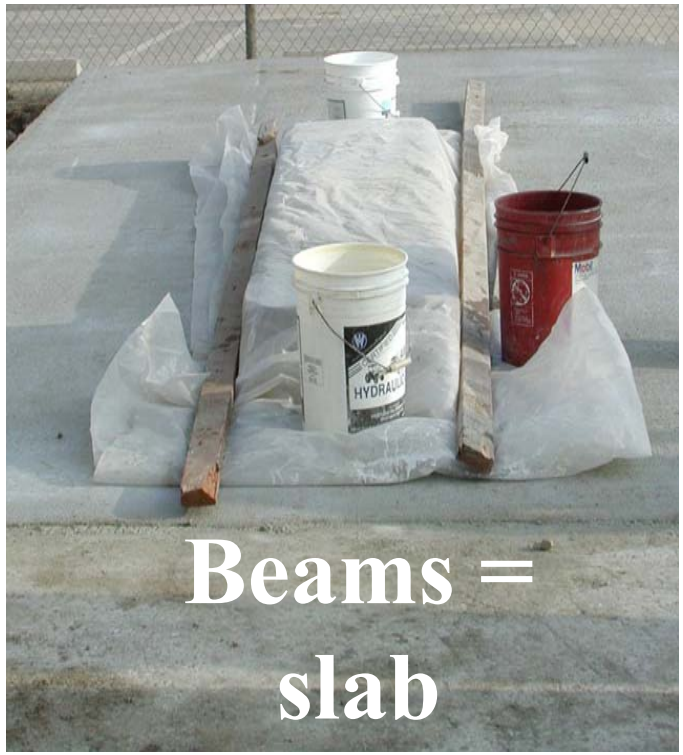
SHRIN



Curing

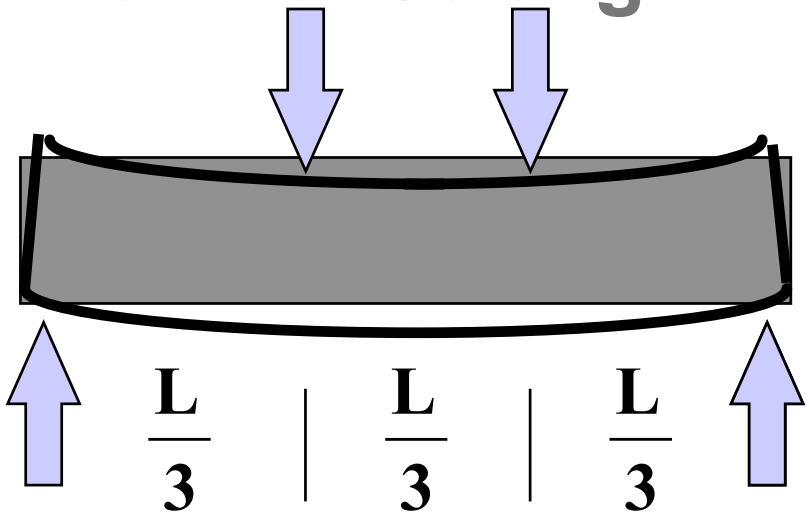
Control moisture & temperature

Spray slab & beams



Beams = slab

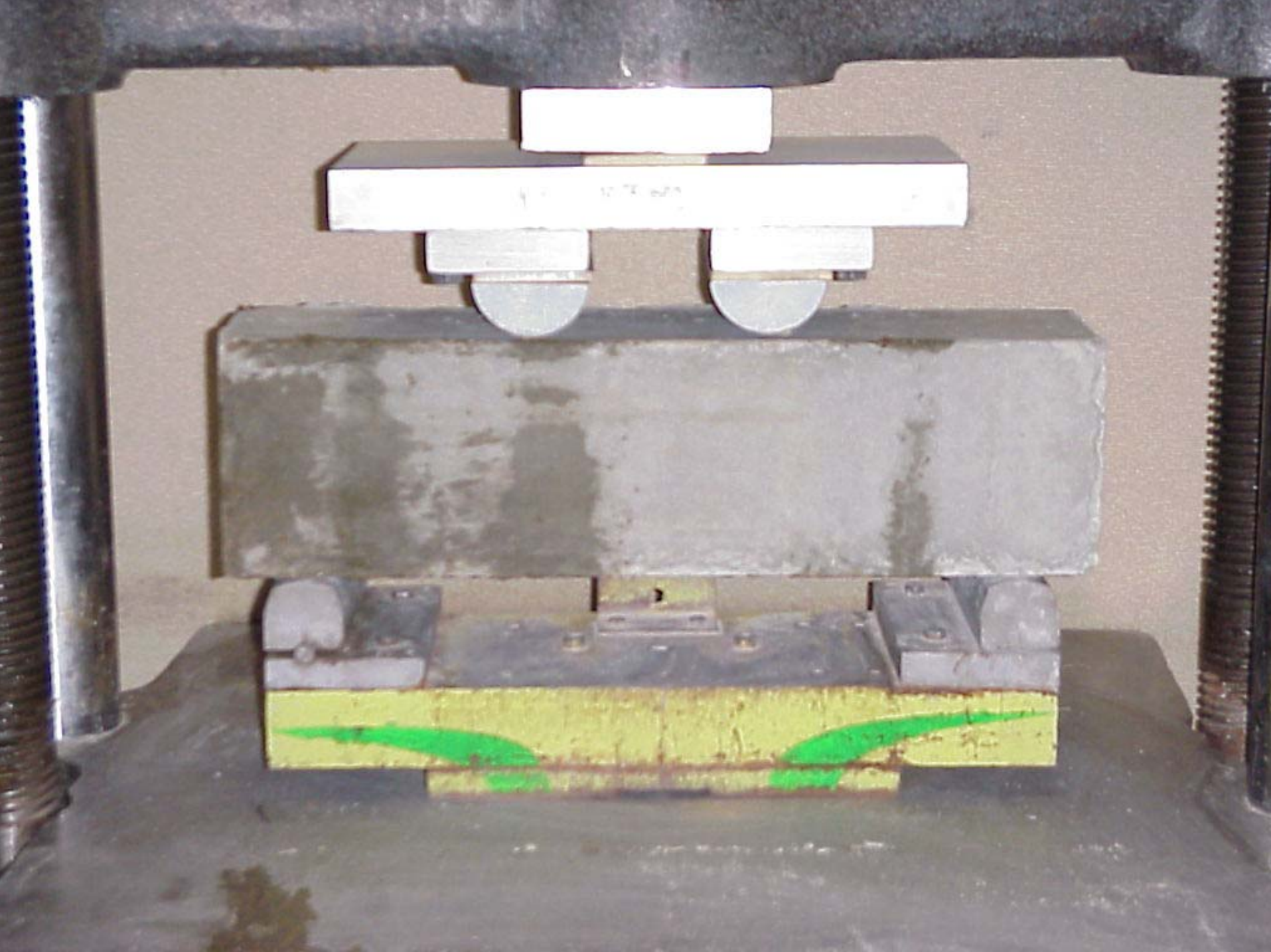
Flexural Strength



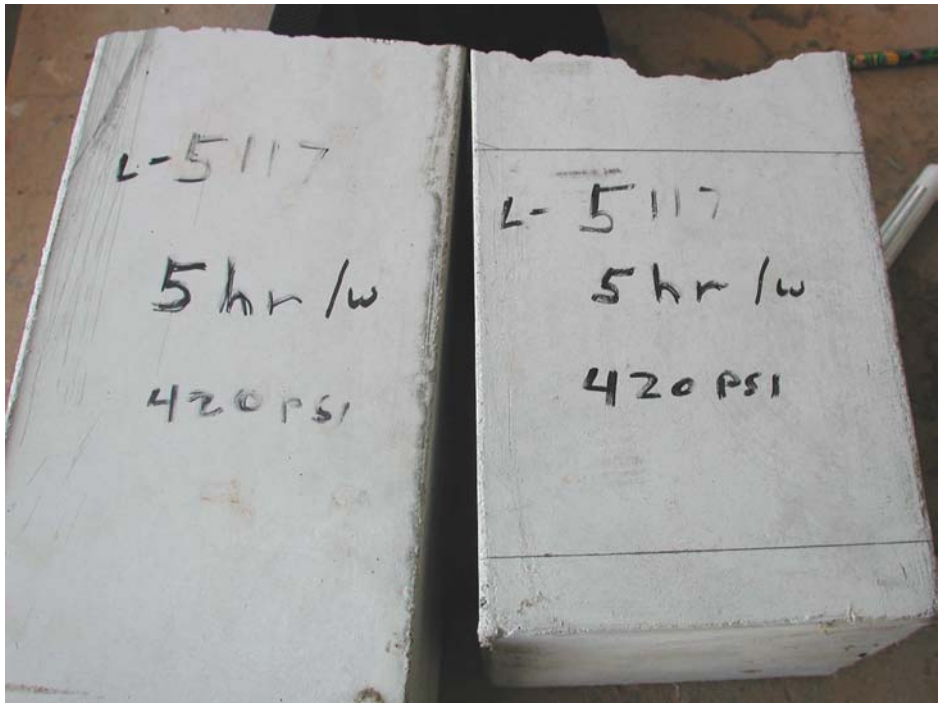
$$f_r = \frac{PL}{bh^2} \cong 7.5 \textit{to} 10\sqrt{f'_c}$$

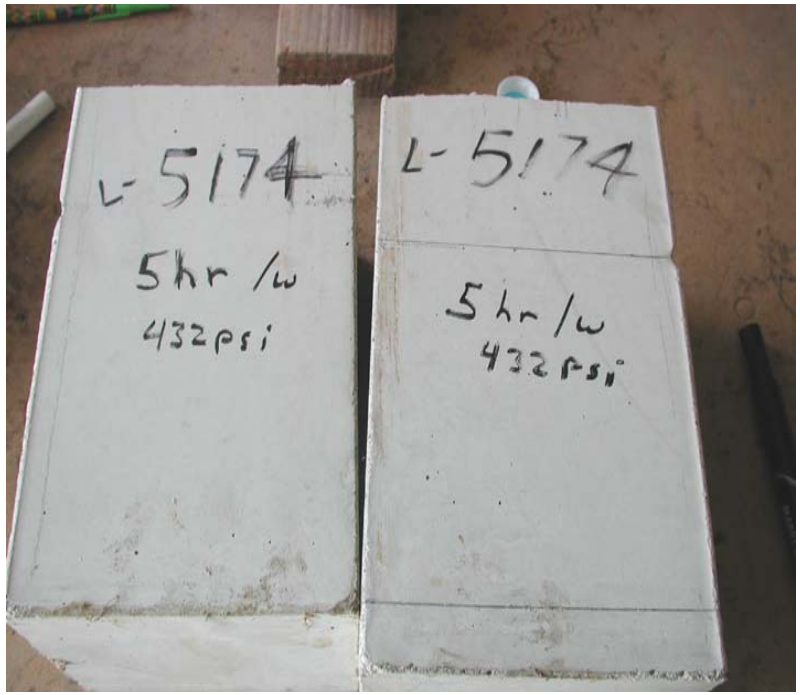
- **Flexural strength of concrete neglected in reinforcement design**
- **Used primarily in unreinforced, pavement, or slab on grade design**


Beam
machine
at
National
1328
Forney Test Equipment
DR 2000



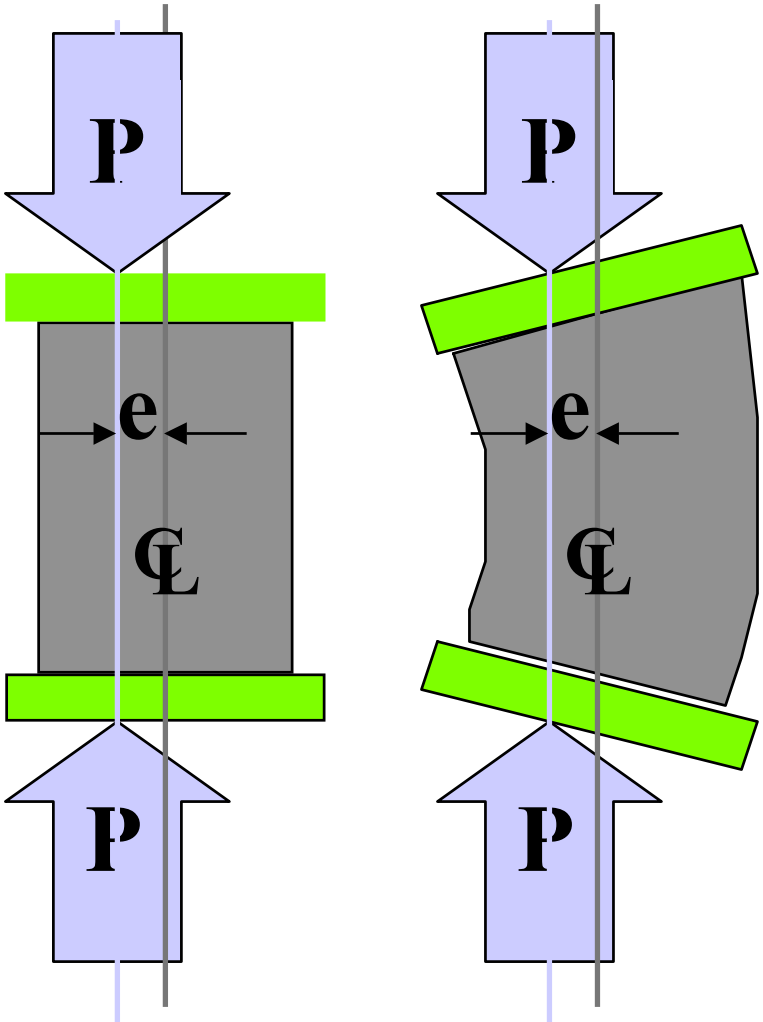
Typical Beam Breaks





Dense uniform

Eccentric Loading



Example of test error

Eccentric loading causes a combination of axial and bending stress distributions

4 X 4 TRIAL BATCH SUMMARY NATIONAL CONCRETE

degussa.
Construction Chemicals Americas

NATIONAL

Trial Batch	1	2	3	4	5
Date	7/17	7/26	7/31	8/28	9/5
Batch Size	3 c.ft.	3.3 c.yd.	10 c.yd.	10 c.yd.	10 c.yd
Slump/Flow (in.)	20	23	43/4	12	8
Unit Weight (pcf)	148.0	149.6	153.0	152.3	153.4
Air Content (%)	1.6	1.1	1.7	1.2	1.6
Concrete Temp (F)	73	83	85	86	87
Air Temp (F)	67	76	59	68	65
Initial Set	1hr-38m	2hr-24m	------	2hr-8m	-----
W/C	0.340	0.377	0.377	0.377	0.377
Compressive Strength (from batch, 1 hour less from placement)					
5 Hours	3,395	2,600	3,695	4,133	4,723
6 Hours	4,415	4,510	4,760	4,873	5,490
7 Hours	5,215	4,730	4,965	5,397	5,640
7 Day	------	8,000+	------	------	9,118
28 Day	7,960	9,275	9,105	9,020	10,015
Flexural Strength (from Batch, 1 hour less from placement)					
5 Hour	-----	427	506	442	479
6 Hour	-----	446	461	507	452
7 Hour	-----	474	497	500	529
7 Days	-----	1,019	1,042	-----	1,069
28 Days	-----	1.169	1,076	1,068	-----

All contained Glenium 3030, Pozzolith NC 534 & same source of Type III cement.
Mix was virtually same as used in Chumo I 405 project.

Flex avg Mpa

4 hr 3.2

5 hr 3.4

6 hr 3.4

7 day 7.2

28 day 7.6

or

1,104 psi

Master Builders Technologies

4 X 4 CONCRETE

degussa.
Construction Chemicals Americas

I 405 CHUMO CONST. & NATIONAL R/M SUMMARY

I 405

	9/14	9/23	9/30	10/7	10/14	10/21	10/28	11/4	Average
CU.YDS.	5 Trial	50	100	107	160	127	200	60	**804 total**
3 Hr. flexural	2.9 427	1.7 251	2.6 376	2.9 413			2.8 404	1.9 280	**2.5** **364**
		2.1 297	2.3 325	2.6 371		3.4 489	2.6 369	2.5 366	
3 Hr. compressive	27.1 3935			25.6 3707			30.4 4410	16.3 2362	**23.9** **3471**
						23.0 3332	22.3 3230	22.9 3320	
3 ½ Hr. flexural			2.7 397	3.1. 441	2.7 381	3.5 510			**3.0** **432**
3 ½ Hr. compressive			23.0 3340						**24.3** **3529**
			21.0 3060	31.7 4602	21.5 3113				
4 Hr. flexural	3.4 488	2.8 406	3.5 499	3.3 473	3.1 451		3.7 537	2.8 403	**3.1** **451**
		2.8 407	3.3 481		2.8 409		3.1 450	2.9 411	
4 Hr. compressive	29.3 4251	23.4 3397	27.7 4010	29.4 4269	35.3 5115		39.9 5790	21.9 3171	**28.3** **4105**
		23.2 3367	25.0 3620					31.7 4063	
7 Day flexural	6.4 931	6.7 962	6.6 952	6.2 898	6.1 882	6.8 987	6.7-6.8 965-983	6.2 892	**6.5** **941**
		6.6 955	6.3 917	6.4 921	6.5 932	6.8 980	6.3 914	6.9 993	
7 Day compressive	52.5 7615	50.3 7300	57.5 8340	57.8 8385	60.1 8720	65.9 9550	54.7-54.6 7925-7910	55.6 8057	**57.4** **8326**
		56.0 8120	60.6 8780	60.3 8750	57.2 8290	63.5 9205	54.3 7870	58.0 8405	

Flex MPa

4 hr 3.1

2.8REQ

7 day 6.5

4.2 REQ

Master Builders Technologies

degussa.
Construction Chemicals Americas

A & A

4 X 4 CONCRETE

A&A / ASSOCIATED CONCRETE

All mixes contain Type III Cement, Glenium 3030NS, Pozzolith NC 534, 1inch top size crushed aggregate, W/C of .32-.34. Early strengths are in hours after placement. Some mixes contain less cement and 15% Type F Fly Ash. All tests by Twining Laboratories.

Date Cast	10/11		10/11		10/18		10/18	
	Trial # 1		Trial # 2		Trial # 1		Trial # 2	
FLEXURAL	Psi	Mpa	Psi	Mpa	Psi	Mpa	Psi	Mpa
3 hour	385	2.67	421	2.9	331	2.3	451	3.1
4 hour	442	3.1	584	4.1	462	3.2	537	3.7
5 hour	565	3.9	655	4.5	543	3.8	613	4.2
24 hour	950	6.6	742	5.1	869	6.0	786	5.4
3 day	1111	7.7	926	6.4	895	6.2	1054	7.3
7 day	1149	7.9	1141	7.9	1026	7.1	1025	7.1
28 day	1243	8.6	1249	8.6	1090	7.5	1210	8.3
COMPRESSIVE								
3 hour	3355	23.1	3510	24.2	2095	14.5	2770	19.1
3 ½ hour	-----	-----	-----	-----	-----	-----	3220	22.1
4 hour	4400	30.4	5005	34.5	4570	31.5	5055	34.9
5 hour	5400	37.3	5940	41.0	-----	-----	-----	-----
24 hour	8710	60.1	8315	57.3	7550	52.1	7930	54.7
3 day	9455	65.2	8795	60.7	8315	57.3	8360	57.7
7 day	10370	71.5	10150	70.0	8720	60.1		
28 day	11220	77.4	10950	75.5	9330	64.3	10535	72.7

Flex Mpa

3hr 2.3-3.1

4 hr 3.1-4.1

5 hr 3.8-4-5

7 day 7.1-7.9

28 day 7.5-8.6

Compressive Psi

28 day 9,330-11,220

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CAN everyone PRODUCE 4 X 4 CONCRETE?

NO

WAY

IS 4X4 A MIX DESIGN?

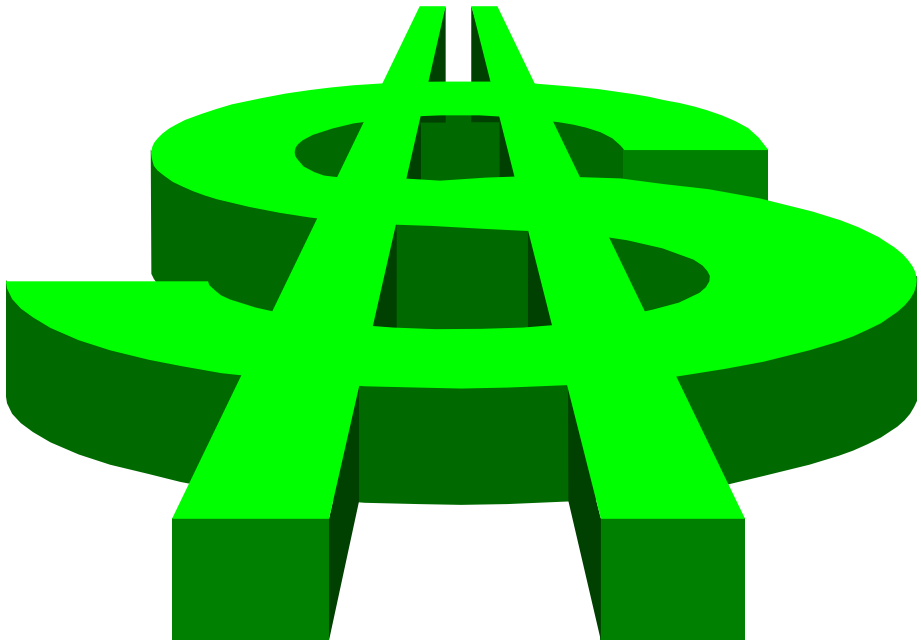
NO!

4 X 4 IS A **SYSTEM**

IT A BLEND OF MATERIALS USED WITH *CONTROLLED PROCEDURES*.

QUANTITIES MUST BE ALLOWED TO VARY!!

4X4 CONCRETE SYSTEM MAKES ECONOMIC SENSE FOR EVERYBODY

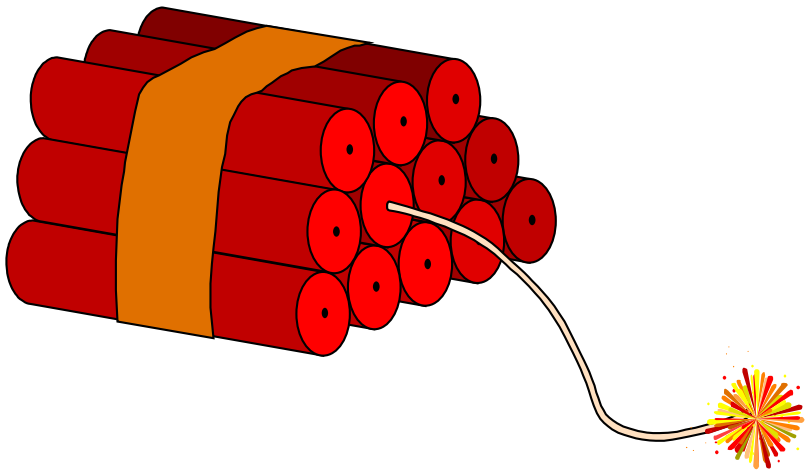


Loaded R/M Truck in 4 Hours

Are these guys happy?

QUESTIONS

NOW OR LATER



- PEOPLE HERE THAT CAN GIVE MORE INFORMATION ARE
- MAC MCCLELLAND MBT
- TRACY MOSELEYMBT
- PHIL ZIVICH MBT

- DAVE LANG National Concrete
- MIKE CHAMBERS A&A Concrete
- BORIS STEIN Twining Labs.

Canada to San Diego

Thank You